

Design of an IVA test mannequin model as a learning media for midwifery students at the Tasikmalaya Health Polytechnic, ministry of health

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ABSTRACT

Introduction: Cervical cancer remains one of the leading causes of cancer-related deaths among women in Indonesia, particularly in developing countries. The *Visual Inspection with Acetic Acid* (IVA Test) is a simple, affordable, and sensitive method recommended by the World Health Organization (WHO) for early detection. However, many healthcare workers, including midwives, still lack sufficient skills in performing the test. This study aims to develop a *prototype* of an IVA Test manikin as an innovative learning medium to enhance midwifery students' competencies. **Methods:** This research employed the *Research and Development (R&D)* approach through stages including anatomical graphic design of the cervix, *prototype* fabrication using medical-grade silicone, and simulation of acetic acid application using hypochlorite acid. The cervical part was designed modularly with litmus paper that turns white when applied with hypochlorite, mimicking a positive IVA reaction. Validation and consultation were conducted with material and media experts to assess design accuracy and functionality. A small-scale trial was carried out involving 10 midwifery students from Poltekkes Kemenkes Tasikmalaya. **Results:** The *prototype* successfully resembled the realistic shape, color, and texture of the cervix. Expert validation indicated that the manikin met anatomical and functional criteria, while student trials demonstrated that the model was easy to use, improved understanding of procedural steps, and increased confidence in performing the IVA Test. **Conclusion:** The developed IVA Test manikin serves as an effective, practical, and sustainable learning innovation to enhance midwifery students' clinical skills in cervical cancer early detection. Further studies with larger samples and expert validation are recommended to optimize its educational model/video.

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INTRODUCTION

Cervical cancer remains one of the leading causes of cancer-related mortality among women in Indonesia, with particularly high incidence rates in many developing countries (WHO, 2023). Visual Inspection with Acetic Acid (VIA/IVA Test) is recommended as a screening method due to its low cost, simplicity, and adequate sensitivity. However, the implementation of effective cervical cancer screening programs is influenced by multiple factors, including midwives' clinical competence, availability of appropriate training resources, and organizational support within healthcare settings (Zarbiv et al., 2025) (Dagne & Beshah, 2021; Zarbiv, Perlman, & Ellen, 2025). Previous studies indicate that midwives' competence, confidence, and access to continuous skills training play a crucial role in determining the quality and effectiveness of reproductive health services delivery (Afulani et al., 2021). Empirical studies also confirm that VIA demonstrates acceptable sensitivity and specificity for cervical cancer screening when performed by adequately trained health providers, supporting its continued use in resource-limited settings (Basaleem et al., 2021)

Recent global evidence shows that Visual Inspection with Acetic Acid (VIA/IVA Test) remains a highly effective screening method for cervical cancer in low- and middle-income countries due to its simplicity, affordability, and acceptable diagnostic accuracy when performed by trained health providers (Catarino et al., 2020; Sankaranarayanan et al., 2021). Despite its advantages, the effectiveness of VIA is strongly influenced by the examiner's clinical skills and experience, particularly in identifying acetowhite lesions and the squamocolumnar junction (Arbyn et al., 2020).

Midwifery students, as future healthcare professionals, require effective learning media to enhance their skills in performing the IVA Test. Conventional learning methods that rely on demonstrations using patients or static models have several limitations, particularly in terms of accessibility and anatomical realism. Simulation-based learning using mannequins has been shown to improve clinical knowledge, psychomotor skills, and confidence (Cant & Cooper, 2020; Ahn et al., 2023; Batkin Ertürk et al., 2024). Beyond its practical application, the development of an IVA mannequin also contributes theoretically to competency-based clinical learning in midwifery. Simulation-based education, grounded in experiential learning principles, facilitates the integration of cognitive knowledge, psychomotor skills, and clinical reasoning through structured and repeated practice (Aebersold, 2021; Cant & Cooper, 2020). In this context, a high-fidelity IVA mannequin with anatomically accurate and functionally responsive features can operationalize competency-based learning by enabling students to develop diagnostic accuracy and procedural competence in a controlled environment. Thus, the IVA mannequin extends existing simulation models by emphasizing the role of anatomical and functional fidelity in strengthening competency-based clinical training.

However, existing IVA simulation media still present important limitations. Many models rely on simplified or static representations of the cervix that do not adequately depict key anatomical structures such as the squamocolumnar junction (SCJ) or variations in cervical morphology (Gray et al., 2023). In addition, although simulation improves procedural competence, limited emphasis on realistic visualization of acetowhite changes following acetic acid application may reduce students' ability to accurately interpret clinical findings (Arbyn et al., 2020; Catarino et al., 2020). Furthermore, low-cost and hybrid simulators often prioritize accessibility over fidelity, resulting in insufficient integration between anatomical accuracy and functional simulation (Munangati et al., 2022).

These gaps indicate the need for more advanced simulation media that incorporate high-fidelity cervical anatomy alongside realistic clinical responses. Therefore, this study aims to develop an IVA Test mannequin model with anatomically accurate specifications and functional simulation features to enhance midwifery students' clinical competence and better prepare them for real-world cervical cancer screening practice.

RESEARCH METHOD

The research method used in this study is the Research and Development (R&D) approach. Research and Development is a method designed to produce a specific product and to test the effectiveness of that product. The sample in this study consists of 40 midwifery students, with 10 students participating in the small-scale trial and 30 students in the large-scale trial. The data analysis techniques used in this study include both quantitative and qualitative approaches. Quantitative data are obtained from questionnaires in the form of scoring assessments conducted by the material expert (Nunung Yulia, M.Si, Apt.), the media expert (Fery Fadly, MKM), and students. Qualitative data are gathered from suggestions and feedback provided by both the media expert and the material expert. Development Design: Problem Identification In the first step, the researchers conducted a preliminary study to identify the problem by interviewing students in the Midwifery Department of Poltekkes Tasikmalaya. Data Collection Various information relevant to the planning process was gathered, including references and learning materials collected from library books and journals related to the feasibility of learning media design. Product Design After the data were collected, the next step was to design the product in the form of a mannequin model intended as learning media for the IVA Test. The development stages of the IVA Test mannequin in this study align with recommended principles for designing and implementing simulation-based education programs, including realism, learner engagement, and structured skill progression (Cheng et al., 2021). Design Validation Design validation was carried out prior to field testing. This validation was conducted by one material expert and one media expert. Design Revision Design revisions were made to improve weaknesses and deficiencies identified during the validation process by the material expert and the media expert. Product Trial In this stage, the initial trials were conducted with 10 students for the small-scale test and 30 students for the large-scale test. However, in this study, the process is limited to the small-scale trial only.

RESULTS AND DISCUSSIONS

Initial Design

The study produced a graphic design of the IVA Test mannequin based on cervical anatomy. This design was developed by considering various cervical conditions (normal, inflamed, IVA-positive).

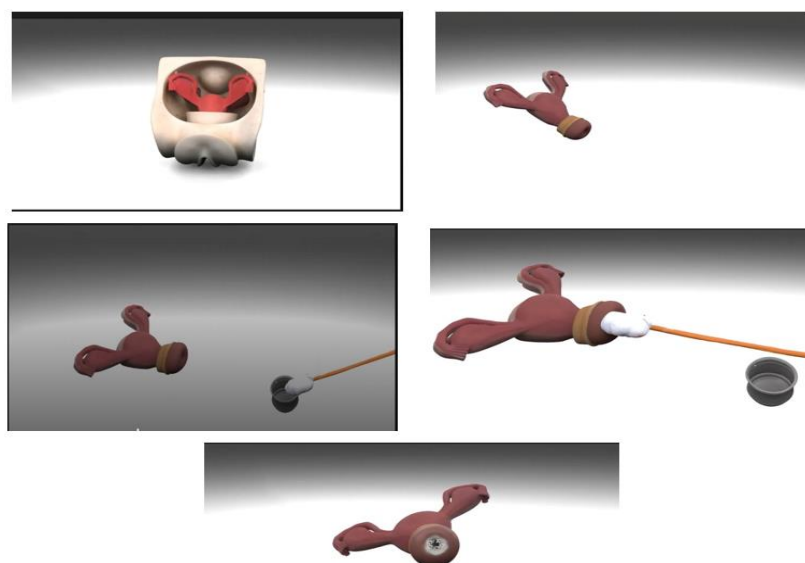


Figure 1. Graphic design of the IVA test mannequin (digital prototype)

Clinical References

To develop the design, the researchers used documentation of actual cervical conditions before and after the application of acetic acid as references for determining shape, color, and texture.

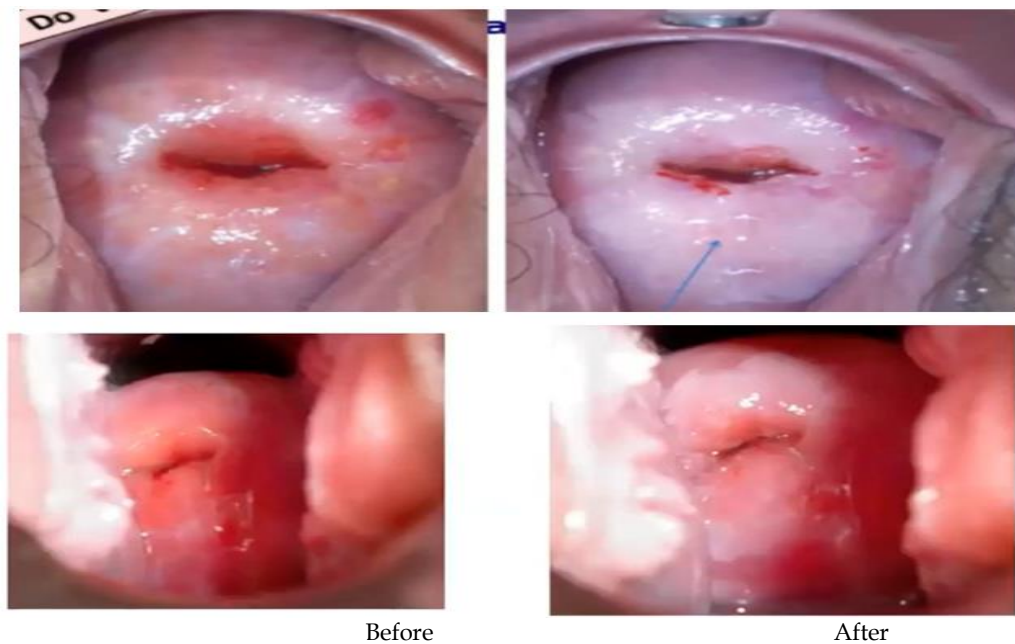


Figure 2. Cervix before and after the application of acetic acid

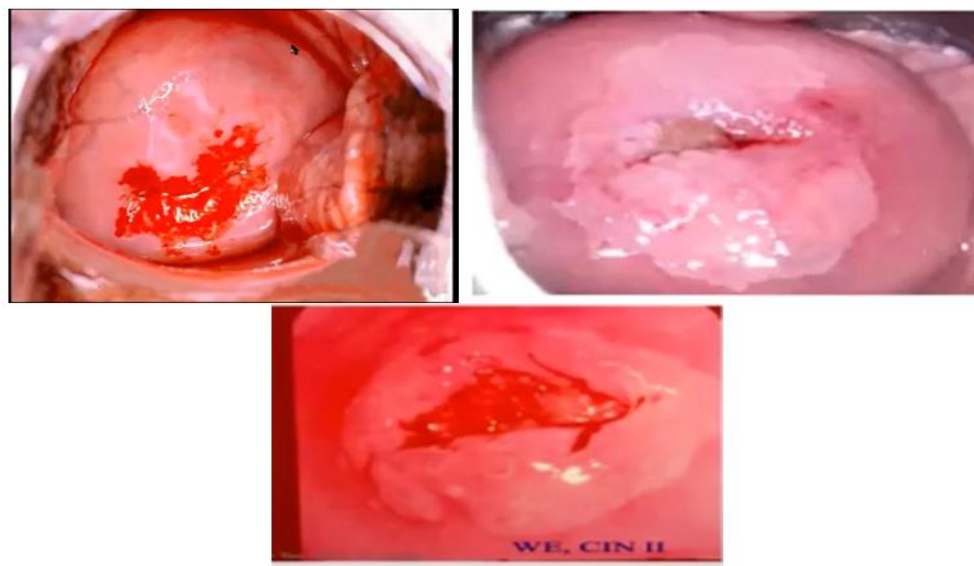


Figure 3. Example of a cervix with a positive IVA lesion

IVA Test Mannequin Prototype

The prototype was developed using medical-grade silicone with a resin/acrylic base. The cervical component was designed to be modular, allowing it to be replaced to simulate different conditions (normal, inflamed, IVA-positive).

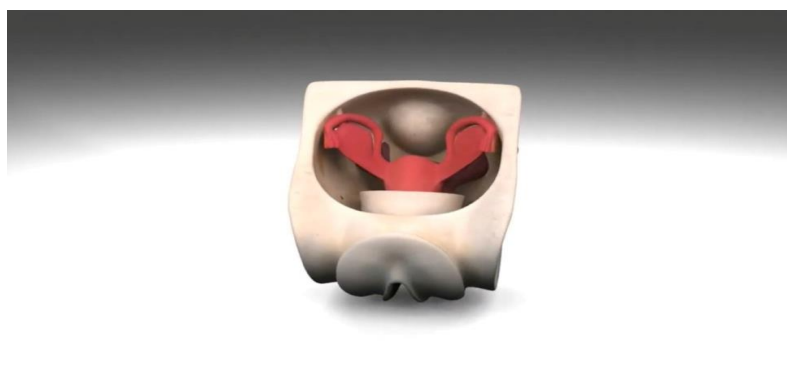


Figure 4. Front view of the mannequin prototype

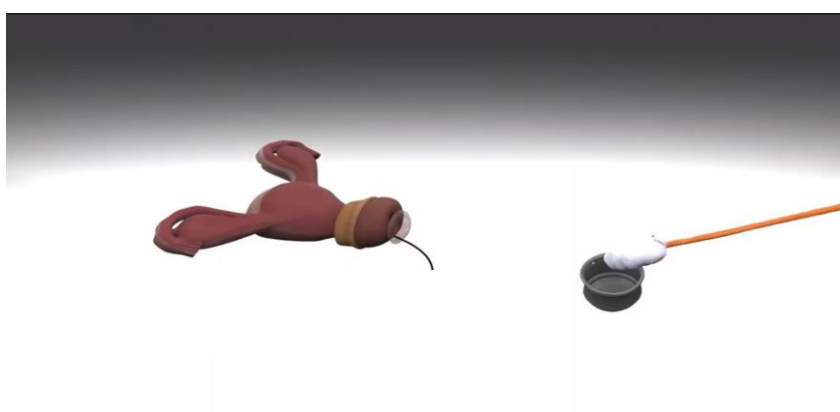


Figure 5. Pink litmus paper is applied to the portio

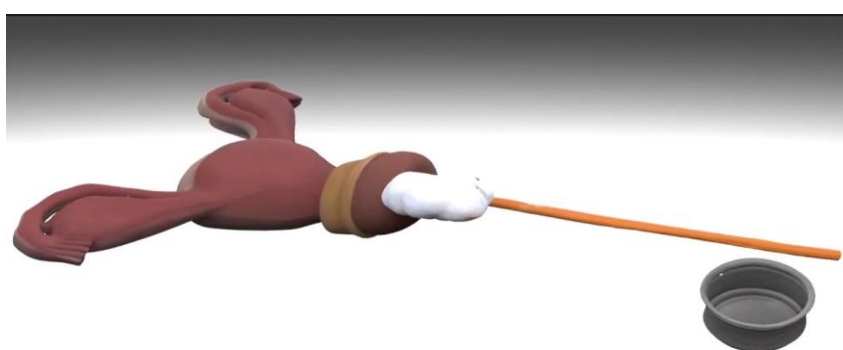


Figure 5. Prototype with simulated examination using Hypochlorous acid-soaked swab

Table 1. Specifications of the IVA Test Mannequin Prototype

Component	Description
Size	Diameter \pm 2,5-3 cm
Colour	Light pink - grayish white (positive simulation)
material	Silicon medical grade
liquid	Acetic acid is replaced with hypochlorous acid
Add material	Pink litmus paper

The selection of materials and the simulation of chemical reactions in the IVA mannequin have important implications for the clinical validity of the learning process. The use of medical-

grade silicone contributes to tactile realism, allowing students to experience a texture that closely resembles the human cervix, which is essential for developing psychomotor skills and procedural familiarity. This aligns with previous findings that material fidelity plays a significant role in enhancing learners' skill acquisition and confidence in simulation-based education (Aebersold, 2021; Cant & Cooper, 2020).

However, the substitution of acetic acid with hypochlorous acid combined with litmus paper, while safe and practical, introduces certain limitations related to biochemical accuracy. In real clinical settings, the IVA test relies on the coagulation of nuclear proteins in abnormal epithelial cells, producing an acetowhite appearance that requires careful visual interpretation (Arbyn et al., 2020; Catarino et al., 2020). The simulated color change in this model represents a simplified reaction, which may not fully capture the variability, subtlety, and gradation of actual cervical lesions.

Consequently, while the mannequin demonstrates strong functional and visual approximation, it may not entirely replicate the diagnostic complexity encountered in real patients. This suggests that the model is highly effective for early-stage training, particularly in improving procedural skills, anatomical orientation, and learner confidence, but should be complemented with additional clinical exposure or high-fidelity visual training to strengthen diagnostic accuracy.

Overall, the integration of realistic materials and safe chemical simulation represents a balanced approach between educational effectiveness, safety, and cost-efficiency, although further refinement is needed to enhance the clinical validity of IVA response simulation.

Data analysis:

1. Testing the Feasibility of IVA Test Mannequin Prototype
 - a. Feasibility Test by Material Experts

Table 2. Validation results of of IVA test mannequin prototype by material experts

No.	Statement	Score
Suitability of Material		
1.	Completeness of material	5
2.	Breadth of material	5
3.	Depth of material	5
4.	Suitability of media and material	5
Accuracy of Material		
5.	Accuracy of concepts and definitions	5
6.	Accuracy of images and materials	4
7.	Accuracy of terms	5
Encouraging Curiosity		
8.	Ease of understanding language	5
9.	Encouraging curiosity	5
10.	Creating the ability to ask questions	5
Total Score		49
Average		4,9
Value (%)		98%

Based on table 2 above, it is known that the average value of the validation results from material experts is 4.9 (98%). Thus, of IVA Test Mannequin Prototype " is included in the very feasible category and can be used without revision.

- b) Feasibility Test by Media Experts

Table 3. Validation results of of IVA test mannequin prototype by media experts

No.	Statement	Score
Design/Display Quality		
1.	Layout of input, buttons, and output	5
2.	Suitability of background selection (Skins)	4
3.	Suitability of font size and type selection	4
4.	Color suitability	5

No.	Statement	Score
The Quality of Button		
5.	Attractiveness of button display	5
6.	Regularity and consistency of button display	4
7.	Accuracy of button reaction	5
Media Efficiency		
8.	Convenience of video use	5
9.	Convenience of selecting video menus	5
10.	Convenience of entering and exiting the video	5
Total Score		47
Average		4.7
Value (%)		94%

Based on table 3 above, it is known that the average value of the validation results from media experts is 4.7 (94%). Thus, of IVA Test Mannequin Prototype is included in the very feasible category and can be used without revision.

1. Conducting Design Revisions Based on Validation from Material Experts and Media Experts. Here are some suggestions and inputs given by media experts, namely: a) The boundary between the darker and lighter outer areas should be clarified, specifically the Squamocolumnar Junction (SCJ); b) Enlarge the text; c) In the video, pink litmus paper is used
2. Testing the Video Design "IVA Test Mannequin Prototype": Small-Scale Trial A small-scale trial was conducted on 13 female adolescents at Poltekkes Kemenkes Tasikmalaya.

Table 4. Small-scale test by adolescents

No	Respondent	Respondents' Score for Each Question										Total	Percentage	Category
		1	2	3	4	5	6	7	8	9	10			
1.	1	4	5	5	4	5	5	5	5	5	5	48	96%	VF
2.	2	4	4	4	4	3	4	3	4	4	5	39	78%	F
3.	3	5	5	4	5	4	5	4	5	5	4	46	92%	VF
4.	4	4	3	4	5	4	5	4	4	5	5	43	86%	VF
5.	5	4	4	4	4	4	4	4	4	5	5	42	84%	VF
6.	6	4	4	4	4	4	4	4	4	4	4	40	80%	VF
7.	7	4	5	4	4	5	5	5	5	4	5	46	92%	VF
8.	8	4	3	4	4	4	4	3	4	4	4	38	76%	F
9.	9	5	5	5	5	5	5	5	5	4	4	49	98%	VF
10.	10	5	5	5	5	5	4	5	5	4	5	48	96%	VF
		Total										711		
		Average										44,4	88%	VF

Based on table 4 above, the results of the small-scale test conducted on 10 students regarding the feasibility of the " IVA Test Mannequin Prototype were declared very feasible with an average value of 88%. All respondents stated that the " IVA Test Mannequin Prototype" Video could be used.

Table 5. Small-scale test by students (feasibility based on questions)

No.	Statement	Interpretation		
		Total	Presentage	Category
Convenience of Use				
1.	Is the IVA Test Mannequin Prototype easy to use?	29	96.6%	VF
2.	Is the IVA Test Mannequin Prototype easy to use?	25	85%	VF
3.	Is the Android-Based Application IVA Test Mannequin Prototype easy to enter and exit the program?	27	90%	VF
4.	Is the IVA Test Mannequin Prototype feasible to use as a health education media for students?	27	90%	VF
Clarity of Material				
5.	Is the material contained in the IVA Test Mannequin Prototype easy to understand?	28	93.3%	VF
6.	Are the images contained in the IVA Test Mannequin Prototype in accordance	27	90%	VF

No.	Statement	Interpretation		
		Total	Presentage	Category
	with the material?			
7.	Is the content of the material in the IVA Test Mannequin Prototype clear enough?	28	93.3%	VF
	Display/Design of Application			
8.	Is the overall display of the IVA Test Mannequin Prototype appropriate?	27	90%	VF
9.	Is the placement of buttons/bottoms of each menu appropriate?	28	93.3%	VF
10.	Is the background appearance in the IVA Test Mannequin Prototype appropriate?	25	85%	VF
	Total Score	282	880	
	Average	28.2	88,0%	Very Feasible

Based on table 4 above, the results of a small-scale test conducted on 10 female adolescents regarding the feasibility of the "IVA Test Mannequin Prototype" Videowere stated to be very feasible with an average value of 88.0%. All respondents stated that the "IVA Test Mannequin Prototype" Video could be used: a) The graphic design corresponds to actual cervical anatomy; b) The initial prototype resembles the real texture and color of the cervix; c) The modularity allows for more varied learning experiences; d) These results are consistent with the findings of Nugraheni et al. (2021), which emphasize the importance of simulation media in improving IVA Test skills among midwifery students.

The results of the study indicate that the developed VIA test mannequin serves as an effective, practical, and sustainable learning innovation in improving the clinical skills of midwifery students, particularly in the early detection of cervical cancer. The effectiveness of this media is evident in the students' ability to understand the examination procedure more deeply through clear anatomical visualization and risk-free, repeatable practice (Zhou & Lassen, 2025). The findings of this study are consistent with previous research indicating that simulation-based learning tools significantly improve students' procedural accuracy, confidence, and readiness for real clinical settings (Al Gharibi & Schmidt, 2022; Omer, 2022). The modular design and realistic anatomical features of the developed VIA test mannequin further support effective experiential learning, as recommended in contemporary midwifery education literature (Aebersold, 2021). Furthermore, the practical aspect is reflected in the mannequin's design, which is easy to use, easy to maintain, and can be applied in various practicum sessions without requiring special facilities. This model also offers sustainability because it can be used long-term as a learning aid that meets the needs of basic to advanced skills training. Thus, the development of this VIA test mannequin not only improves the quality of learning but also strengthens students' readiness to provide cervical cancer screening services in the field. This innovation is consistent with the International Confederation of Midwives' global standards, which emphasize competency-based education, clinical skill mastery, and the use of appropriate learning technologies in midwifery training (Fullerton et al., 2022).

CONCLUSION

The developed IVA Test manikin serves as an effective, practical, and sustainable learning innovation to enhance midwifery students' clinical skills in cervical cancer early detection. Further studies with larger samples and expert validation are recommended to optimize its educational video. In line with current global recommendations, integrating simulation-based learning media into midwifery education is a sustainable approach to improving the quality of cervical cancer screening services (Cant & Cooper, 2020). The IVA Test mannequin developed in this study demonstrates strong potential as a standardized educational tool to support competency-based learning and clinical skill mastery among midwifery students. From a practical perspective, its integration into the curriculum can support structured and standardized skills training by enabling

repetitive, safe, and supervised practice, reducing reliance on patient-based learning, and facilitating objective competency assessment through methods such as skills checklists and OSCE (Aebersold, 2021). Moreover, its cost-effective and durable design makes it particularly relevant for implementation in resource-limited educational settings, supporting scalable and sustainable midwifery training (Munangatire et al., 2022).

Future research should focus on rigorously evaluating the effectiveness of IVA mannequin-based simulation on clinical learning outcomes through robust study designs, such as randomized controlled or quasi-experimental studies comparing simulation with conventional training. Key outcomes should include diagnostic accuracy, psychomotor skills, clinical decision-making, and skill retention, assessed using objective measures such as OSCE and expert evaluation. In addition, multi-center and longitudinal studies are needed to enhance generalizability and examine the transfer of simulation-based learning into real clinical performance. Further refinement of mannequin fidelity, particularly in simulating acetowhite reactions and cervical anatomical variations, is also essential to strengthen the clinical validity and educational impact of IVA training.

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